

E7.3 10.02.8

CR-129956

MAPPING OF THE MAJOR STRUCTURES OF THE AFRICAN RIFT
SYSTEM USING ERTS-1

Dr. PAUL A. MOHR
SMITHSONIAN ASTROPHYSICAL OBSERVATORY
60 GARDEN STREET
CAMBRIDGE, MASS. 02138

JANUARY 1973
TYPE II REPORT FOR PERIOD JULY - DECEMBER 1972

(E73-10026) MAPPING OF THE MAJOR
STRUCTURES OF THE AFRICAN RIFT SYSTEM
USING ERTS-1 Progress Report, Jul. -
Dec. 1972 (Smithsonian Astrophysical
Observatory) 7 p HC \$3.00

N73-15360

CSCL 08F

G3/13

Unclas
00026

PREPARED FOR

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. 1	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle MAPPING OF THE MAJOR STRUCTURES OF THE AFRICAN RIFT SYSTEM USING ERTS-1		5. Report Date January 1973	
		6. Performing Organization Code	
7. Author(s) DR. PAUL A. MOHR		8. Performing Organization Report No.	
9. Performing Organization Name and Address SMITHSONIAN ASTROPHYSICAL OBSERVATORY 60 GARDEN STREET CAMBRIDGE, MASS. 02138		10. Work Unit No.	
		11. Contract or Grant No. NAS5-21748	
12. Sponsoring Agency Name and Address GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND 20771 MR. EDMUND F. SZAJNA		13. Type of Report and Period Covered TYPE II JULY-DECEMBER 1972	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract (200 word summary from P. Mohr) The structural margin of western Afar with the Ethiopian plateau is marked by a rather wide zone of crustal deformation. ERTS-1 imagery has now permitted a more precise mapping of the structures of this marginal zone, and in particular of the discontinuous marginal graben. The tectonic style of the graben is different in the north from the south, and in the latter region the graben is discordant with the regional tectonic trend. The structural margin of southern Afar with the Somalian plateau is formed, in the western sector, by a remarkable series of fault-zone splays. Afar-plateau boundary fault-zones successively curve northeast and then NNE to become Afar floor fault-zones, with a distance of about 25km separating successive turn-offs. The transition from Ethiopian rift to Gulf of Aden trend faulting along this margin is fascinatingly complex. A simplistic crustal thinning model *			
17. Key Words (Selected by Author(s)) (to be supplied by P. Mohr) Rift Margin Structures		18. Distribution Statement	
19. Security Classif. (of this report) U	20. Security Classif. (of this page) U	21. No. of Pages	22. Price*

*For sale by the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Figure 2. Technical Report Standard Title Page

16. Abstract cont.

is not adequate to explain all observed structural features of the Afar margins.

TYPE II REPORT

JULY - DECEMBER 1972

MAPPING OF THE MAJOR STRUCTURES OF THE
AFRICAN RIFT SYSTEM USING ERTS-1

Submitted by: Dr. Paul A. Mohr

Introduction:

The structures of the Afar margins offer a key to an understanding of the transition from continental to oceanic crust, in a region of newly initiated sea-floor spreading. These structures were originally mapped by the author from aerial photography, with detailed or reconnaissance ground-control in many sectors, but the ERTS-1 imagery now permits a more precise regional synthesis and interpretation. A simplistic crustal thinning model is not adequate to explain all observed structural features of the Afar margins.

The Afar marginal graben

ERTS-1 imagery permits a precision to the precision to the previous mapping and discussion of the Afar marginal graben (Mohr 1967). This discontinuous string of narrow graben extends along the western edge of Afar, and except in the north directly abuts the main escarpment of the Ethiopian plateau.

The most northerly graben, the Maglala-Renda Coma graben, is a southerly development of important meridional tectonics in the Buri peninsula, and extends along meridian 40°E between latitudes 14°30'N and 13°50'N. It has sinuous margins, but averages a width of 7-8km. It is distinctly oblique to the NNW, Red Sea-trend tectonism of northern Afar, and appears in many sectors to parallel the Precambrian basement structures. At its southern end the graben structures are funnelled into a 2km-wide zone of intense deformation: this style of deformation is difficult to reconcile with purely distensional tectonics.

The Dergaha-Sheket graben is likewise situated along meridian 40°E, between latitudes 13°05'N and 12°34'N. Its width is 4-6km, and it shows a sudden change of trend from NNW in the north to NNE in the south. It lacks direct structural continuation with the Maglala graben to the north, and to the south there is a 30km dextral offset into the GufGuf graben.

The GufGuf graben trends NNE between latitudes 12°40' and 12°20'N, and NNW between 12°20' and 11°50'N. It averages 15km width, and in its northern sector the western margin is down-warped rather than faulted. Persistent ENE-trending faults affect the southern sector of the GufGuf graben.

The complexity of the Menebay-Hayk graben, offset 20km dextrally from the GufGuf, is confirmed by the ERTS-1 imagery. The graben trends SSE from latitude 11°45'to 11°10'N, and its width is similar to that of the GufGuf. The graben terminates in high, dissected terrain in the Lake Ardibbo region.

Graben structure is resumed along the same alignment as the Menebay-Hayk graben, south from latitude 11°05'N, and continues SSE to latitude 10°30'N as the Borkenna graben, 9-13km wide. The trend of the Borkenna graben is notably askew from the regional NNE tectonism of the Afar floor and the Ethiopian plateau, to either side. At 10°30'N the graben is 'pinched', and the narrow Robi graben extends due south to latitude 10°10'N, close to meridian 40°E. Here the marginal structures can no

farther compete with the intense, NNE-trending tectonism of the main Ethiopian rift, and no marginal graben occurs until south of latitude 9°N in the rift itself.

Tectonics of the southern margin of Afar

ERTS-1 imagery makes possible a precision to previous mapping and discussion of the tectonic boundary between Afar and the Somalian plateau (Mohr, 1967).

The western sector of this boundary, between longitudes 39°00' and 40°15'E, is formed by NE-SW fault belts which successively turn NNE away from the plateau rim and extend across the floor of southernmost Afar. Thus plateau-rift boundary faults are continuous northwards along the strike into intra-rift faults, though with a radical decrease in the amount of easterly upthrow. Fault-plane dips appear to remain relatively unchanged.

The average distance between successive 'turn-offs' is fairly constant at about 25km, and from southwest to northeast the individual fault belts can be identified as follows: Aselle-Adama, Kaletta-Boseti-Gariboldi, Siri-Saddeca-Awash, and Gumbi-Assabot. The Saddeca-Awash line continues for 100km NNE-wards across southern Afar as the Wonji fault belt, before encountering a large dextral offset at Ayelu and Amoissa volcanoes.

At longitude 40°15'E, the tectonism and topographic relief of the Somalian plateau rim are subdued, but soon resume eastwards though in new form. Between longitudes 40°15' and 41°05'E, the Oligocene-Miocene flood basalts (with ankaramites and cossyrite hawaiites) are warped down north into Afar and are cut by antithetic faulting. This NE-SW zone of deformation in its turn bends to NNE near longitude 40°E but cannot be traced far into Afar.

Between longitudes 41°05' and 41°30'E the boundary faulting of Afar and the Somalian plateau trends ENE. This faulting changes rather abruptly at its eastern limit to E-ESE synthetic faults, well exposed south of Dire Dawa. This style of faulting continues east to longitude 42°10'E, the present eastern limit of mapping from ERTS-1 imagery.

It is therefore evident that the southern margin of Afar is formed by an intricate interplay of Gulf of Aden and Ethiopian rift tectonics, and that the influence of the latter is very strong in imposing a pattern of successive sigmoidal fault belts running from rift margin to rift floor.